ENGINEERED PRODUCTS

INDUSTRIAL HOSE

HYDRAULIC HOSE

CONVEYOR BELTS

LIGHTWEIGHT CONVEYOR BELTS

REPLACEMENT PRODUCTS

POWER TRANSMISSION

TRANSPORTATION OE

Conveyor Belts for Underground Coal Mining
- Follow Up to March 2007 Presentation

The Goodyear Tire & Rubber Company

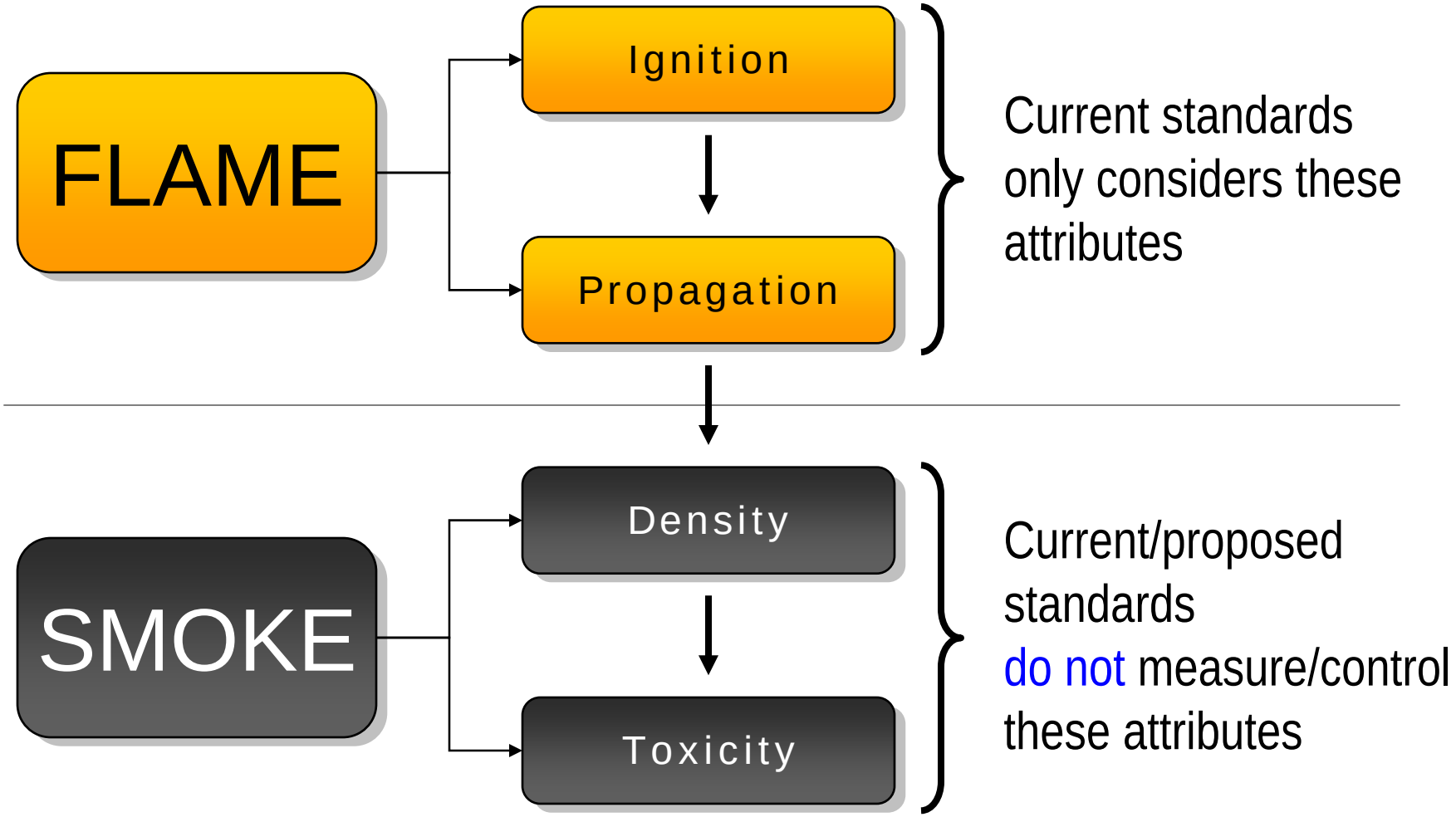
June 20th, 2007

GOODYEAR
ENGINEERED PRODUCTS

Follow Up Items

- Halogen Free conveyor belts meet B.E.L.T.
- Smoke analyses on Halogenated and Halogen Free belts
  - B.E.L.T. unit
  - Cone Calorimeter
  - ASTM E662/BSS 7239
- Static Conductivity Results
- Drum Friction Results

Attributes of Belt Flame Resistance Safety



Belt Safety: Smoke & Halogens

Two groups of flame retardants that can be added to hydrocarbon materials (rubber/plastic)

Halogenated Materials	Halogen Free Materials
Contain Bromine or Chlorine	Use non halogenated materials.
Very effective for propagation resistance	Higher levels needed for propagation resistance
Lower cost than alternate materials	Can be cost effective
Produce thick smoke and toxic gases when heated	Produces significantly **less** smoke and toxic gases when heated

Halogen Free materials are off - the - shelf /commercially available

B.E.L.T Test Data - Halogen Free Belts

Belt Type(Plies fabric/Belt Rating PIW)	2/400	3/600	3/750	4/800	4/1000
Inches of Belt remaining after test (>6”)	27	26	26	28.5	31

Pass on all sizes/ranges used in USA mines

B.E.L.T. Demonstration

B.E.L.T. Demonstration

B.E.L.T. Measurements - Smoke Density

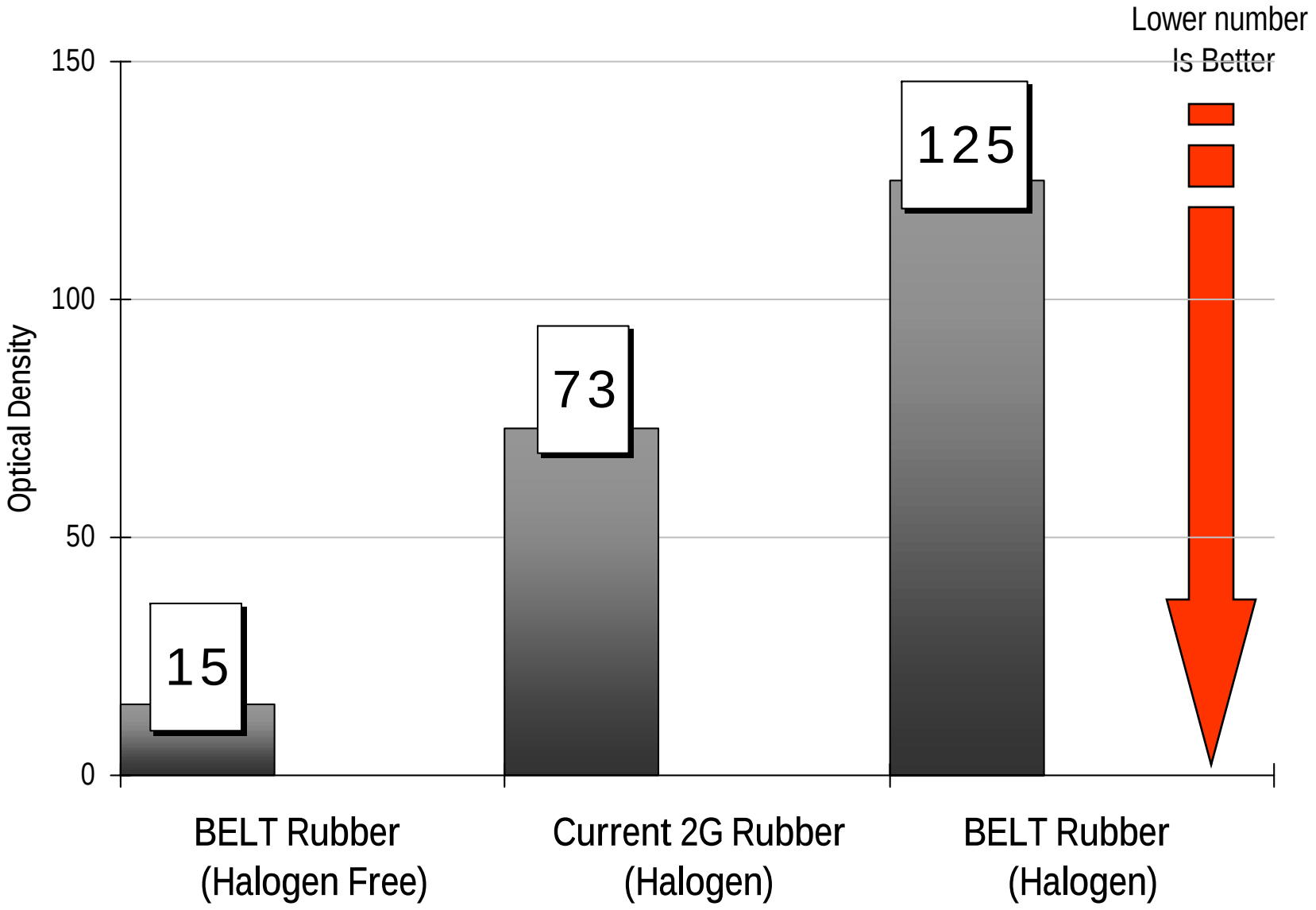
Halogen Free Smoke Density – 25%	Halogenated Smoke Density – 100%

Smoke Analyses - Cone Calorimeter (ASTM E1354)

Belt Material	Halogen Free	Halogenated
Heat Release Rate (kW/m2)	60.4	77.4
CO Yield (kg/kg)	0.03	0.11
HCL (PPM)	0	304
Smoke Density		
Average Smoke Release (m2/kg)	338	757
Total Smoke Release (m2/m2)	2892	6139

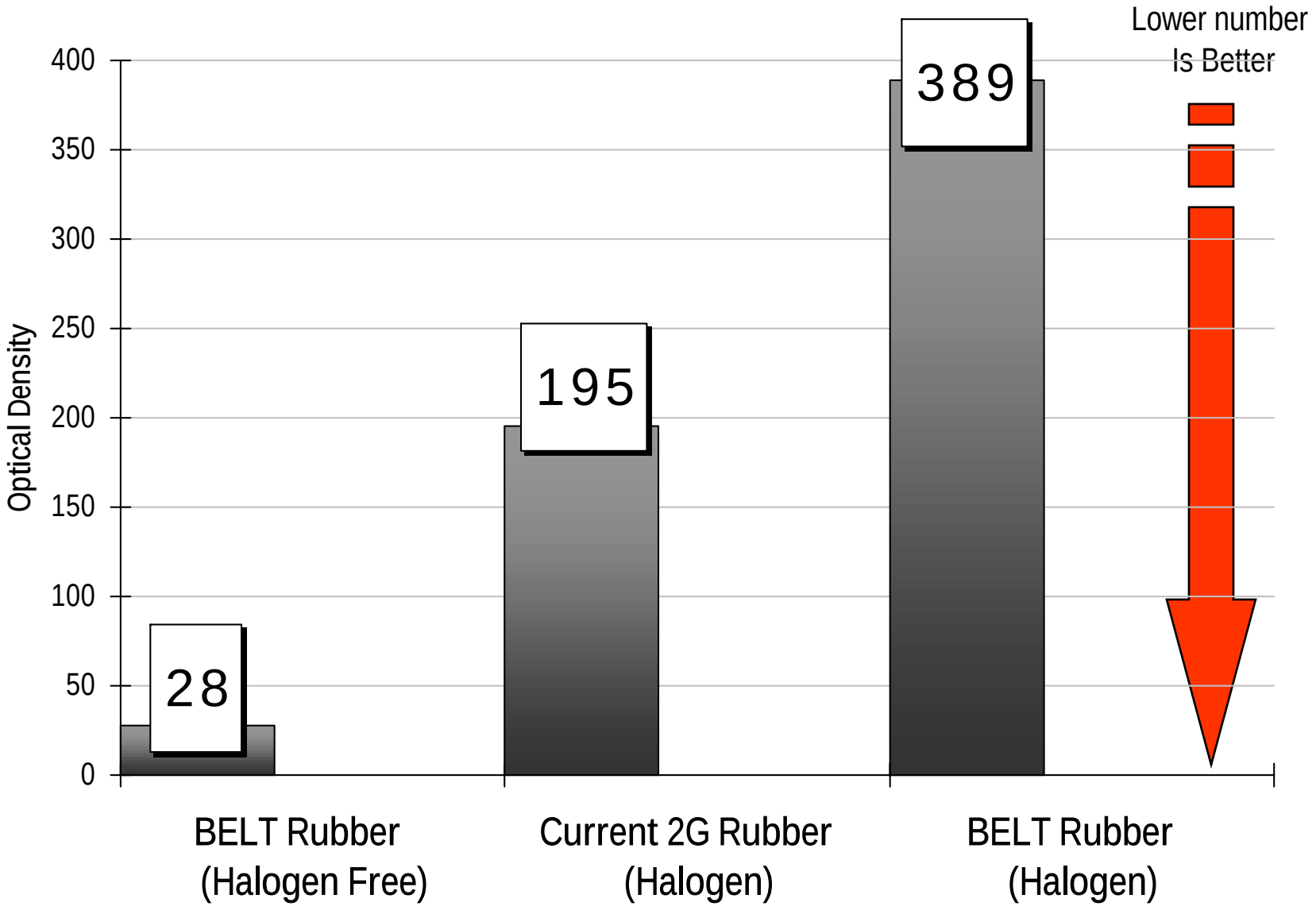
Smoke Density from Belts (ASTM E662)

After 4 Minutes – **Smoldering before Ignition**



Smoke Density from Belts (ASTM E662)

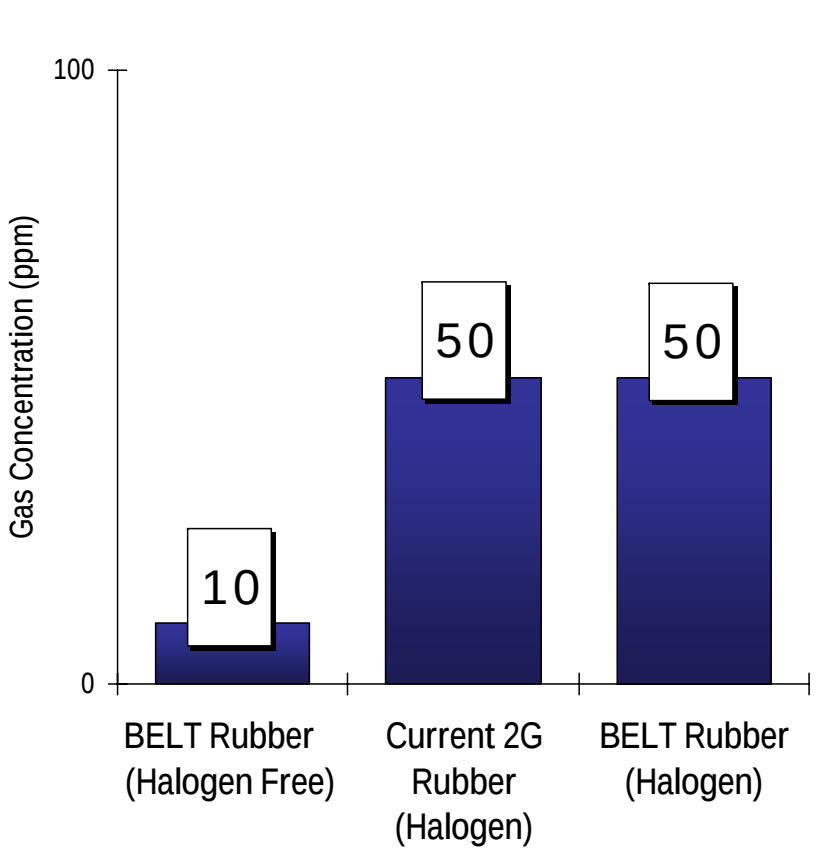
After 4 Minutes – Flaming



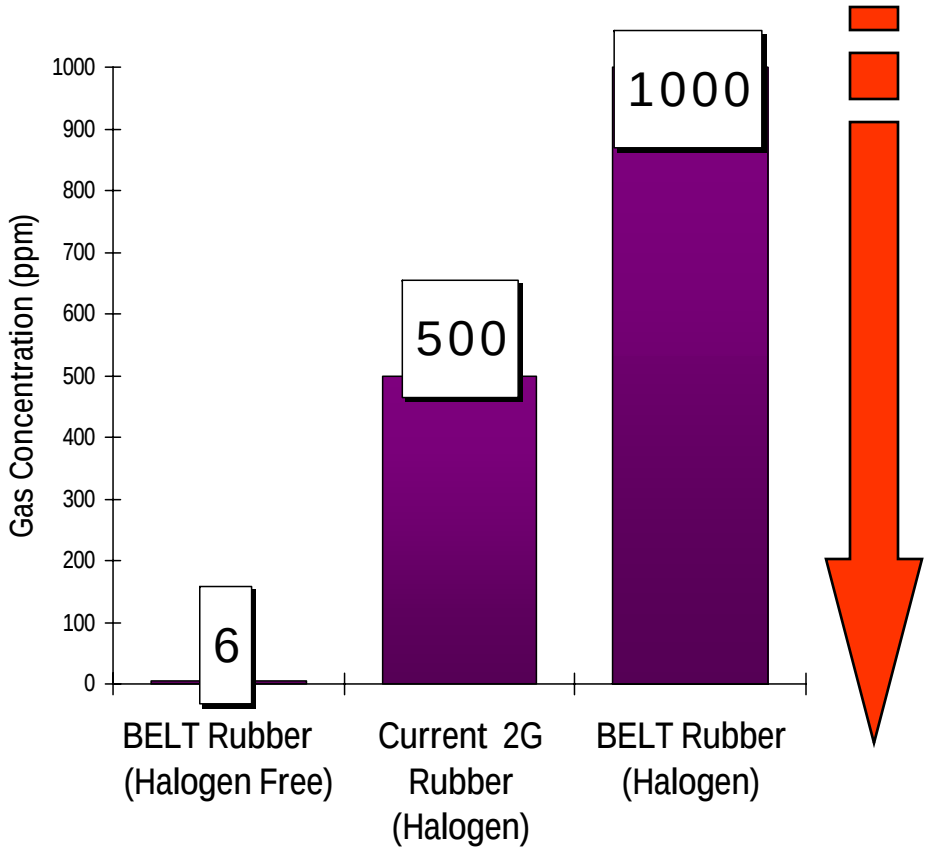
Toxic Gases from Belts (BSS 7239)

After 4 Minutes –**Smoldering before Ignition**

Lower number
Is Better



Carbon Monoxide
(CO)



Hydrogen Chloride
(HCl)

Toxic Gases from Belts (BSS 7239)

After 4 Minutes – Flaming

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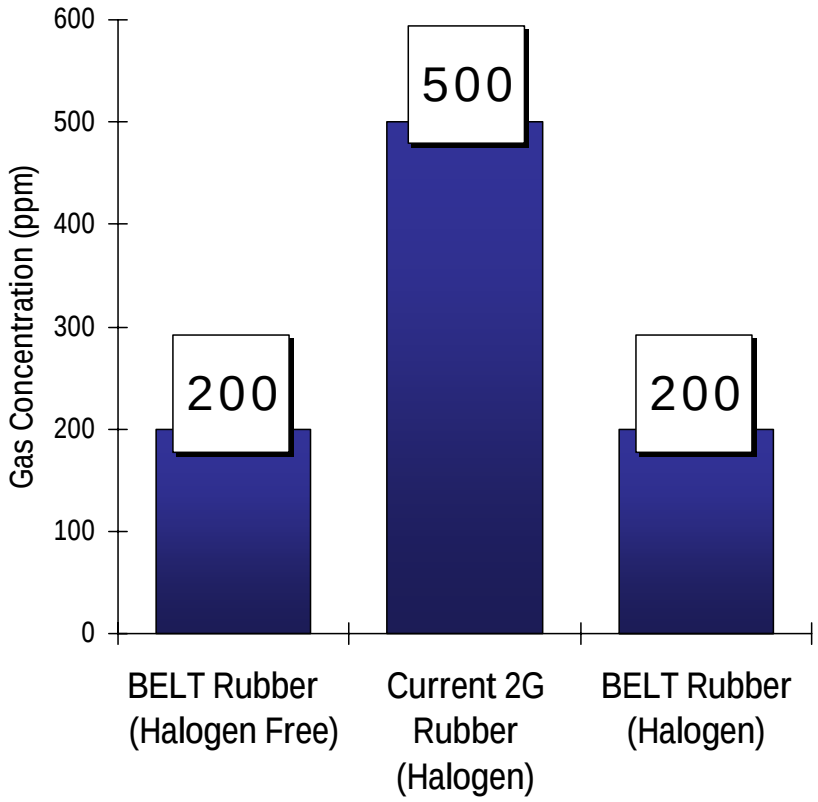

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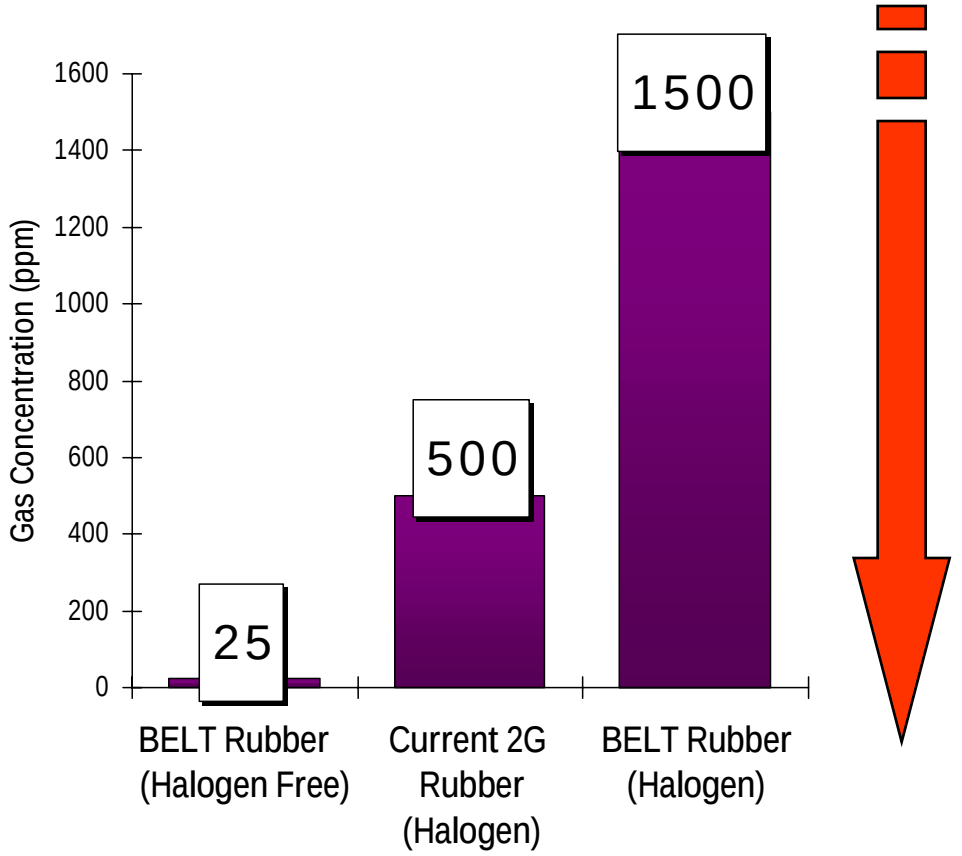

Hydrogen Chloride
(HCl)

Drum Friction / Static Conductivity - Halogen Free

Belt Type	2/400	3/600	4/800	4/1000
Static Conductivity (300 M ohm max)				
Top Cover	0.052	0.045	0.034	0.025
Bottom Cover	0.078	0.069	0.057	0.051
Drum Friction (2 hours, 325C max temp)	150C	140C	100C	115C

Pass on all sizes/ranges

Conclusions / Recommendations

- Halogen Free Materials significantly reduce smoke density and toxicity when smoldering or burning.
- Halogen Free Materials comfortably pass B.E.L.T. requirements/static conductivity/drum friction.
- Smoke Density/Toxicity should be added as part of Flammability Standard for conveyor belts for underground coal mining.
- Drum Friction/Static conductivity should also be added as part of the standard for conveyor belts for underground coal mining.